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NOVA HIGH SCHOOL--SYSTEM ANALYSIS.

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A SYSTEMS ANALYSIS WAS MADE OF A 10TH-GRADE SOCIAL STUDIES COURSE IN AMERICAN HISTORY TAUGHT AT THE NOVA HIGH SCHOOL, FORT LAUDERDALE, FLORIDA, TO EVALUATE THE COURSE AS AN INSTRUCTIONAL SYSTEM. THE ANALYSIS WAS CONCERNED WITH SUCH PROBLEM AREAS AS TEACHER ROLES, THE EFFECTS OF MEDIA ON STUDENT-TEACHER RELATIONSHIPS, INFORMATION REQUIREMENTS, THE USE OF SPACE, AND THE EFFECTS OF COURSE PROCEDURES ON STUDENTS. A COMPUTER SIMULATION MODEL OF THE COURSE WAS SET UP AND TESTED. DATA PRODUCED BY THE MODEL WERE COMPARED TO DATA THAT WERE DESCRIPTIVE OF THE COURSE. THERE WAS A HIGH DEGREE OF CORRESPONDENCE BETWEEN THE SIMULATED DATA AND THE DESCRIPTIVE DATA, INDICATING THAT THE SIMULATION PROCEDURES WERE EFFECTIVE IN PRODUCING DATA THAT APPEARED TO BE VALID. RELATED REPORTS ARE ED 010 568 AND ED 010 569. (GD)

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TECHNICAL

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TECH MEMO

a working paper

System Development Corporation / 2500 Colorado Ave. / Santa Monica, California 90406

Nova High School: System Analysis

ABSTRACT

This Tech Memo is the third in a series of three reporting the work done with Nova High School in connection with the study New Solutions to Implementing Media Through Analysis and Simulation of School Organization. In this document, the 10th-grade Social Studies course in American History is analyzed as an instructional system.

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I. INTRODUCTION

In TM-1493/141/00 the 10th-grade social studies course was described as an instructional system. The purpose of this document is to report the results of the computer simulation modeling of the course and the results of the analysis of the course. The analysis is concerned with the following problem areas:

- Roles of instructional personnel.
- The effects of media on the interactions between students and teachers.
- The information processing requirements.
- The utilization of space.
- The effects of the procedures on the characteristics of the students.

II. TECHNICAL DISCUSSION

A. SIMULATION OF THE 10TH-GRADE SOCIAL STUDIES COURSE

There were two reasons for constructing a model of the course with the computer simulation procedures that have been developed for this purpose:

- The simulation of the course should provide data that will be useful for evaluating the effectiveness of the simulation procedures for modeling instructional plans.
- The processes of formulation, computer programming, and analysis of the output data from the model should provide insights that will be helpful in the analysis.

The description of the course contained in TM-1493/141/00 was used as the basis for formulating the procedures for constructing a simulation model of the course. Figure 1 shows the logical flow that was formulated.

Steps 1 through 34 shows the logic for establishing sections of the course and for starting classes and for terminating units in the course. Four sections of the course were simulated. In each of the four sections a small number of students were assigned to seminar work. Since the sections are treated in the lockstep fashion, each of the four classes can be treated as single students. The simulation involved cycling the sections through the various activities for the equivalent of a semester time. Steps 35 through 80 in Figure 1 show the various activities. The rules for simulating the course operated as follows. For each of the 10 units in the course, each unit was started with a lecture and ended with a unit test. If the program determined that it was the first class of a unit, the simulation started at point A in the flow where the procedures for recording the simulation of time in the lecture are shown. Following the lecture, the activity shown in Box 48 was selected. Sections were randomly assigned 50% of the time to independent study and 50% of the time to small group work. The simulation of independent study is shown in steps 56 through 61, starting at point E. The procedures for simulating small group work are shown in steps 49 through 55. The text under Box 50 shows that when people were assigned to small group work, 7/16 of the time they were assigned to group research, 7/16 of the time they were assigned to discussion, and 2/16 of the time they worked on academic games. The text surrounding Boxes 54 and 60 show that the amount of time spent in small group work and independent study depended upon the previous history of the section. The circled letters show the sequences and the associated time dependencies.

If it was determined that it was the last class in a unit (steps 17-21), the flow was directed to point C where the procedures for simulating the section spending time in testing are shown (Boxes 68-73). Boxes 74 through 80 show the procedures for simulating the special seminar students in independent study.

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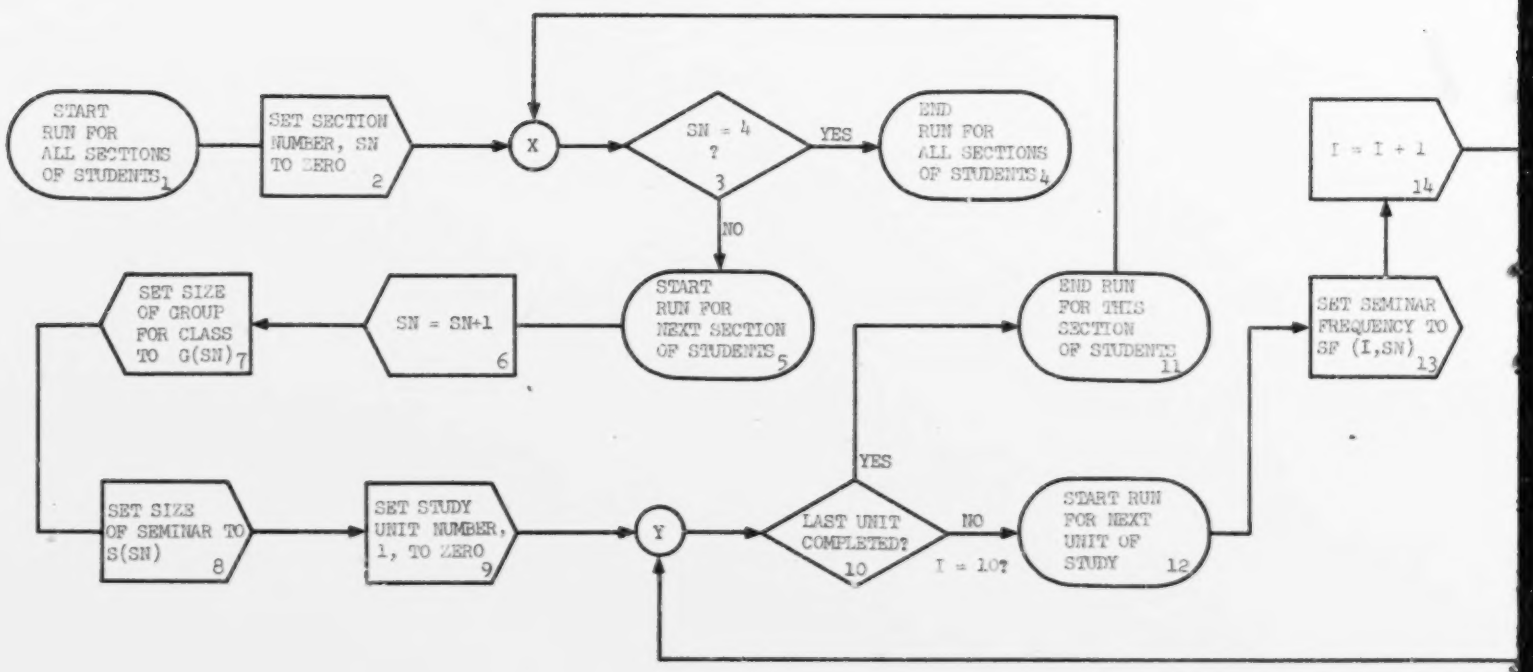
START RUN FOR ALL SECTIONS OF STUDENTS 1
SET SECTION NUMBER, SN TO ZERO 2
X
SN = 4 ? 3
YES
END RUN FOR ALL SECTIONS OF STUDENTS 4
NO
START RUN FOR NEXT SECTION OF STUDENTS 5
SN = SN+1 6
SET SIZE OF GROUP FOR CLASS TO G(SN) 7
SET SIZE OF SEMINAR TO S(SN) 8
SET STUDY UNIT NUMBER, I, TO ZERO 9
Y
LAST UNIT COMPLETED? 10
YES
NO
I = 10?
END RUN FOR THIS SECTION OF STUDENTS 11
START RUN FOR NEXT UNIT OF STUDY 12
SET SEMINAR FREQUENCY TO SF (I,SN) 13
I = I + 1 14
5
Z
CN = CN-1 25
NC (1) = NC (1) -1 24
CN = 1?
IS NEXT CLASS FIRST CLASS OF UNIT? 27
YES
NO
6
A
START FIRST CLASS OF UNIT 28
START SUBSEQUENT CLASS OF UNIT 29
P 30
1 - SF(I,SN)
BRANCH 1 GROUP & SEMINAR
SF (I,SN)
B
PROCESS G (SN) + S (SN) STUDENTS TO REGULAR CLASS 31
BRANCH 2 GROUP ONLY
NO
PROCESS G (SN) STUDENTS TO REGULAR CLASS 32
SEMINAR TO SEMINAR
YES
SEMINAR

Figure 1. Nova High School 10th-Grade Social Studies Mod 5 Simulation Sheet 1

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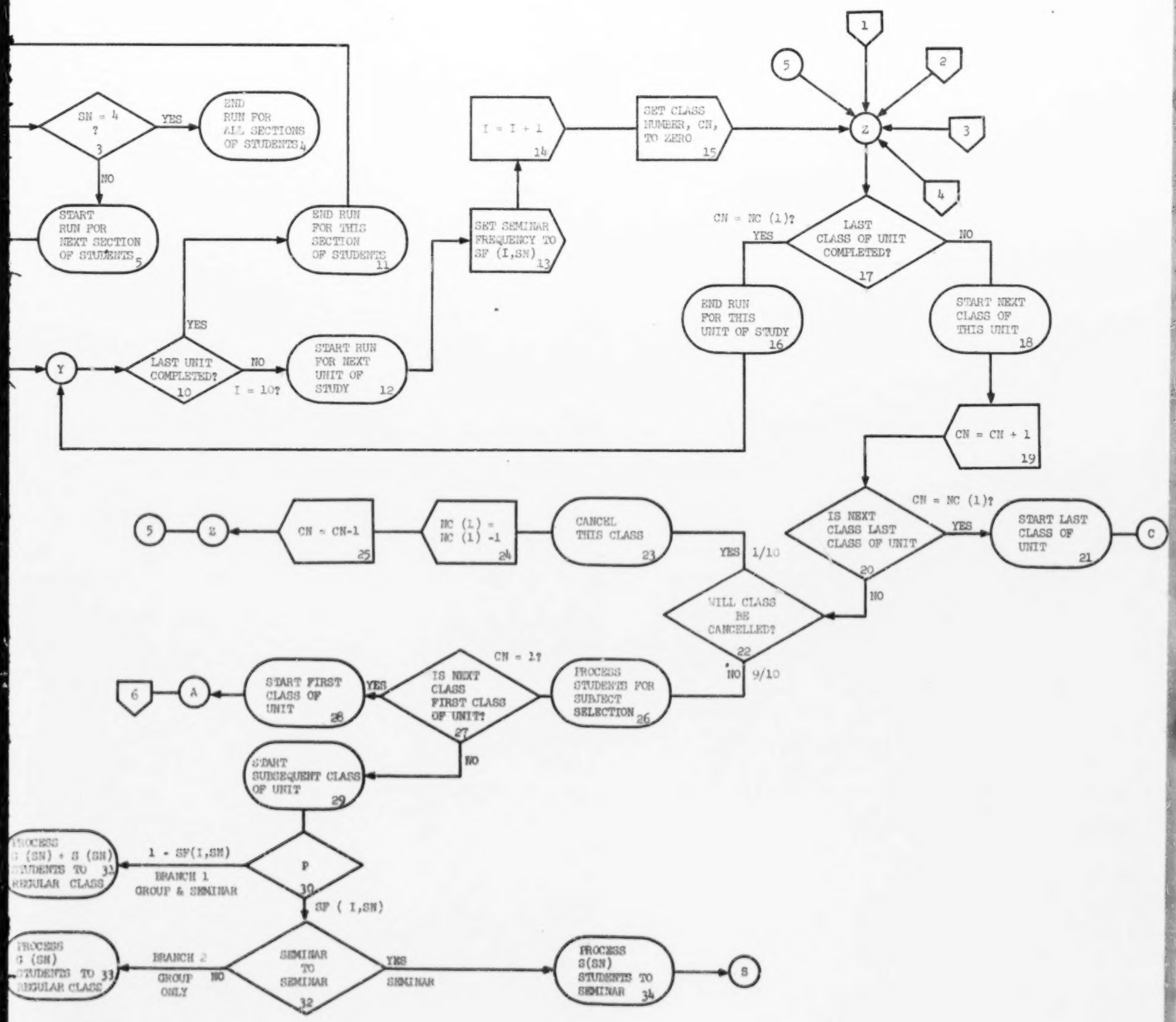

Figure 1. Nova High School 10th-Grade Social Studies Mod 5 Simulation Sheet 1 of 2

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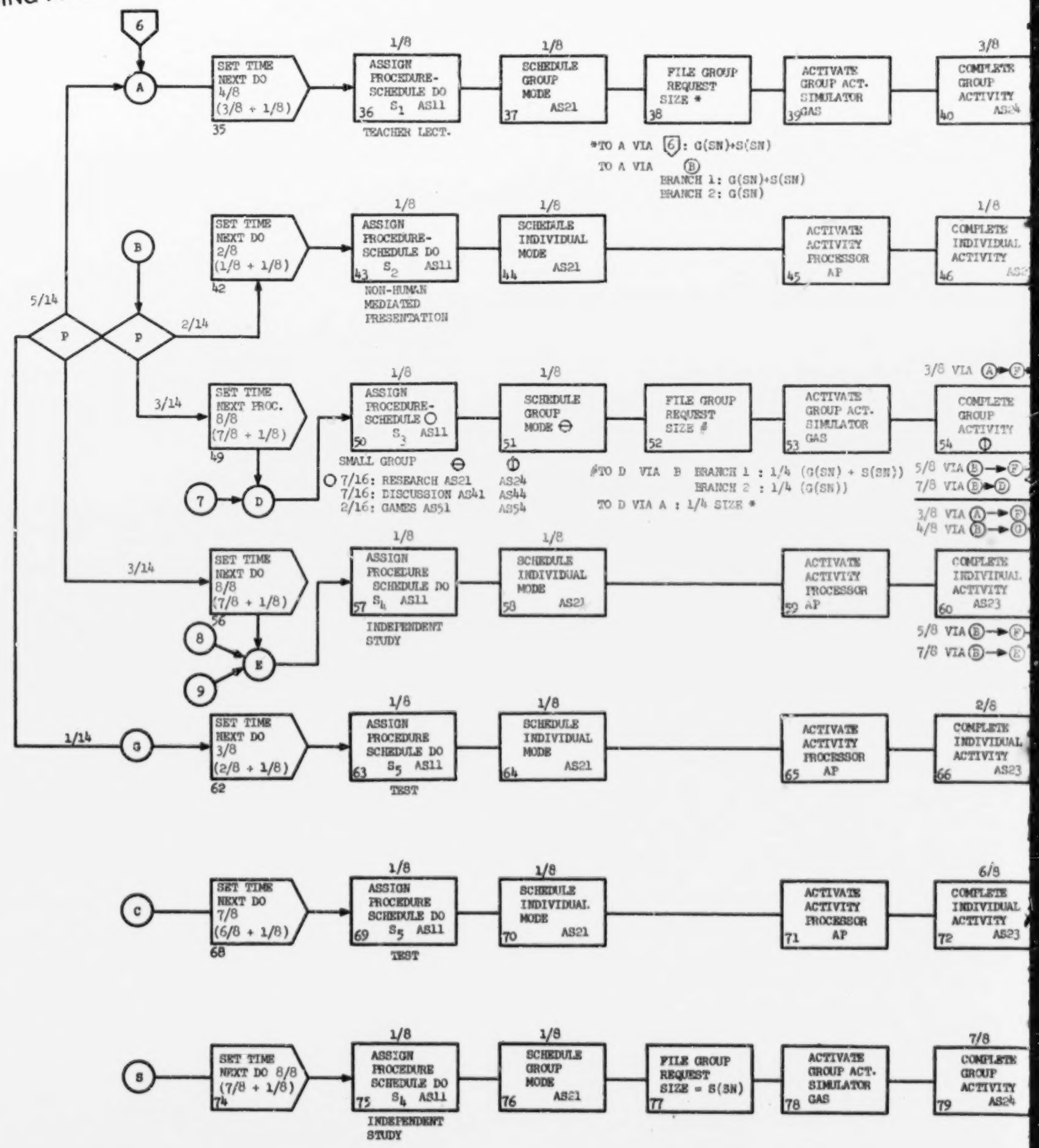

Figure 1. Nova High School 10th Grade Social Studies Mod 5 Simulation

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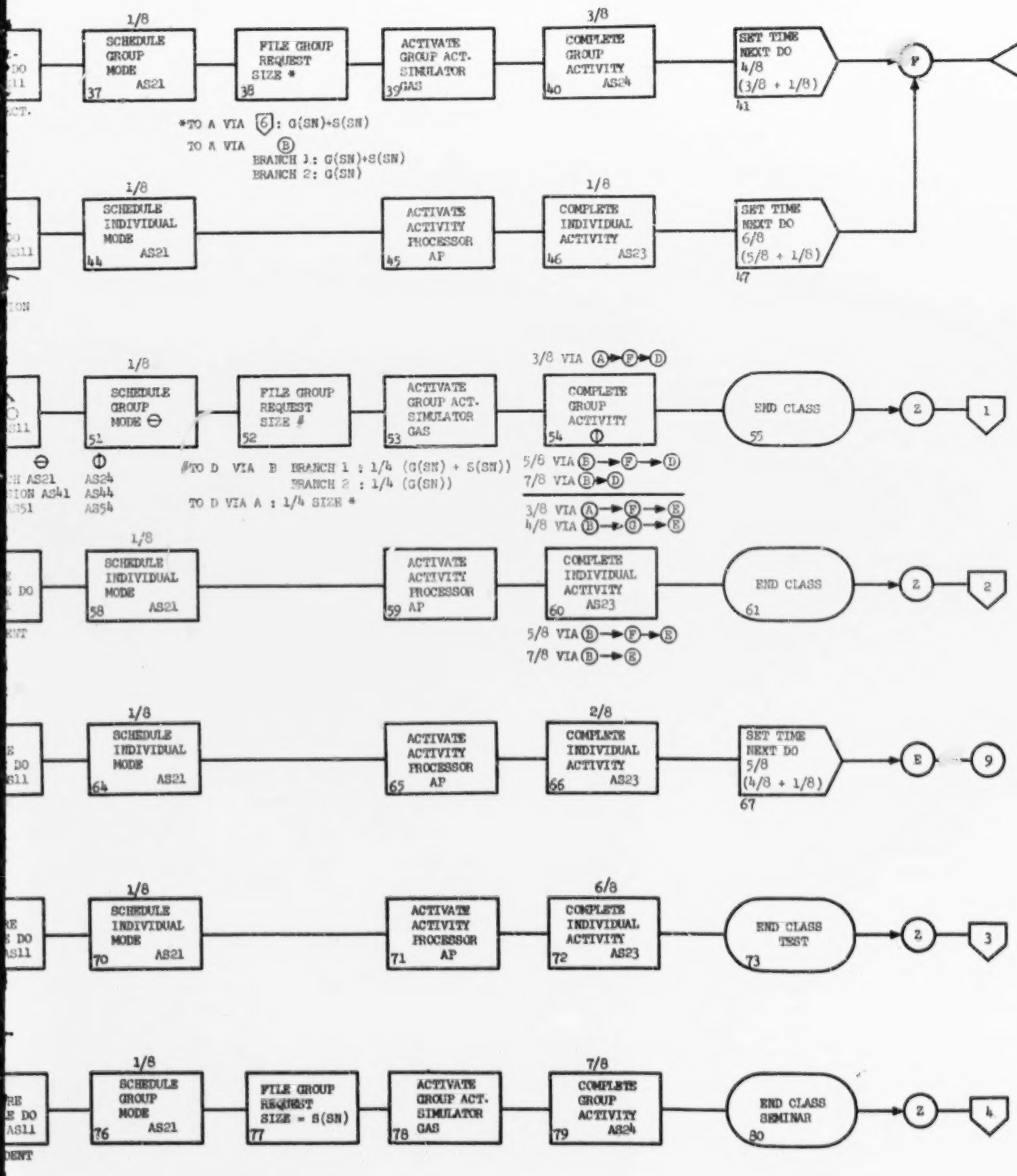

Figure 1. Nova High School 10th Grade Social Studies Mod 5 Simulation Sheet 2 of 2

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If sections were not starting a first class in a unit or were not completing a unit, the flow was directed to point B where the sections were randomly distributed to activities according to the proportions shown. Five-fourteenths of the time they were assigned to a lecture by the teacher (Boxes 35-41). Two-fourteenths of the time they were assigned for a media presentation (Boxes 42-47). Three-fourteenths of the time they were assigned to small group work (Boxes 49-50). Three-fourteenths of the time they were assigned to independent study (Boxes 56-61). And, 1/14 of the time they were assigned to take a quiz (Boxes 62-67). When sections completed a quiz, they went to independent study. When independent study, small group work and unit tests were completed, the class ended, and sections went back to point Z to be assigned to the next class hour.

Table I shows the results of the run which simulated four sections going through a year's work in the course. The activities that were simulated are shown in column 1. Column 2 shows the estimated proportion of time for activities based on the descriptive data in TM-1493/141/00. Columns 3, 5, 7, and 9 show the number of times that each activity occurred for sections 1, 2, 3, and 4 respectively. Columns 4, 6, 8, and 10 show the proportion of the total class time devoted to each of the activities. The total number of class days, the total number of class hours, and the number of class days missed because of holidays and special school activities is shown in the three rows at the bottom of the table. The proportions of time for activities were based upon the amount of class time that was devoted to the activity rather than the number of times that the activity occurred. The average proportion of time spent in independent study for all four sections was 28.9%, whereas the average proportion of time spent in small group work for all four sections was 21.5%. These data indicate that a greater proportion of the time was spent in independent study than in group work even though the number of times that each activity occurred was almost the same. The average number of times for the four sections that sections were assigned to independent study was 76.5; the average number of times that small group work was assigned was 73.5.

B. ANALYSIS OF THE SIMULATION

Examination of the proportions in Table I indicate that the procedures used in simulating the course tend to produce a set of simulated activities that corresponds closely with the proportions that were supposed to be simulated. These data suggest that the computer program logic is correct--that the random generator subroutine does produce variation without bias. The fact that the data for all four sections is very similar increases confidence in the reliability of the simulation procedures.

Contrary to expectations, the procedures for simulating the course were not helpful in suggesting insights into the course that were not already suggested by analysis of the descriptive data. Therefore, the analysis of the course that follows is based primarily upon the descriptive data contained in TM-1493/141/00.

Table I. Results of the Simulation Run

Activities (Column 1)	Estimated Proportions of Total Class Time Based on Descriptive Data (Column 2)	Number of Activities Section 1 (Column 3)	Proportions for Simulated Section 1 (Column 4)	Number of Activities Section 2 (Column 5)	Proportions for Simulated Section 2 (Column 6)	Number of Activities Section 3 (Column 7)	Proportions for Simulated Section 3 (Column 8)	Number of Activities Section 4 (Column 9)	Proportions for Simulated Section 4 (Column 10)
Lectures Large Group	14%	71	14.4%	65	13.7%	56	11.8%	67	14.9%
Media Presentation to Large Group	3%	21	2.8%	22	3.1%	19	2.7%	19	2.8%
Small Group Work	25%	73	20.6%	73	23%	76	21.9%	72	20.4%
Independent Study	29%	82	29.7%	78	26.6%	75	30.6%	71	28.7%
Unit Tests)	6%	10	4.0%	10	5.6%	10	5.6%	10	4.4%
Quizzes)		7	1.0%	10	1.4%	10	1.4%	6	.9%
Attendance & Assignment	7%	165	11.0%	158	11%	158	11%	150	8.9%
End of Class	7%	165	11.0%	158	11%	158	11%	150	8.9%
Miscellaneous Lost Time	9%		5.4%		4.6%		4%		10.1%
Total %	100%		100%		100%		100%		100%
Total Days Class			165		158		158		150
Total Class Hours			186		178		178		169
Days Missed			11		18		18		26

C. ANALYSIS OF THE SOCIAL STUDIES COURSE AS AN INSTRUCTIONAL SYSTEM

The analysis that follows is concerned with the five problem areas--personnel, media, information processing, space, and student characteristics.

1. The Roles of Personnel

The most pressing problem at Nova is the student/teacher ratio of about 1/50. The schools' many advantages have attracted an increased number of applicants and the school is under pressure to take as many students as it can because it serves the entire county rather than a district of the county. The teachers have little time to spend with individual students. The poor student/teacher ratio tends to restrict the alternative instructional plans that can be used. Teachers either must work with the group as a whole, or must require that students work independently a large portion of the time. Forty-six percent of the student's time is spent in the group listening to a lecture or a mediated presentation and in independent study. If the other activities requiring the large group--testing, attendance accounting, and making assignments--is added, 66% of the class time is devoted to large group and independent study. The capacity of the teachers to work with small groups is also limited by the poor student/teacher ratio. Even though the number of small groups is limited to four or less, the small group size (16 to 25) is larger than is generally considered desirable for effective small group work. Two teachers with a section that divides into four small groups can only spare one-half of their time with each group.

If it is assumed that approximately 53 hours of class time during the course are spent in independent study, that the average class size is 71, and that two teachers work with the class, the teachers can spend only 90 minutes a year with each student. At this rate a teacher can spend only an average of nine minutes with each student on each unit of the course. Students do not all need an equal amount of time with the teacher, but the limited resource for individual consultation with students means that if teachers spend more than the average time with very many students, they will exclude some students from any individual consultation.

There are a number of solutions to this problem. By far the best possible solution is to reduce the poor student/teacher ratio by either decreasing the size of the student body or by increasing the size of the staff.

Another solution is to make greater use of para-professionals such as college students and student helpers. Steps in both of these directions have been taken in the course. The students have been instructed in group procedures in the hope that they can take major responsibility for the small group work. In addition, college students have been used to help with test-scoring.

Teachers should develop procedures for identifying and training students and para-professionals with competencies that can be used in the course in such a way that groups can be of smaller size and that students who need individual help can be tutored by people who are capable of helping them.

An additional solution which is under consideration at Nova is to restrict the teaching responsibilities of teachers so that they can use their time more effectively. The idea under this plan is to make teachers responsible for individual units in the course rather than the total course. In this way the teachers can devote their energies to becoming expert in a more restricted range of the course content. This idea should improve the quality of instruction and also should provide more time for teachers to work with students.

Another solution to the problem is to improve testing and information processing procedures so that both students who need help and students who are capable of helping can be identified.

The major difficulty with most of these solutions is that they require the time of the teaching staff for development.

One way of obtaining more teacher time is to make greater use of the instructional media available at Nova.

2. Use of Media

Approximately 17% of the class time is devoted to lecture presentation by the teachers. Only about 3% of class time is used for presentations that are mediated by nonhuman means. When the excellent facilities are considered, it is surprising that there is so little use of media at Nova. If teachers use the facilities available, the teacher lectures could be produced so that teachers would need to devote considerably less time to large group presentation. When the hours required for preparing a group lecture plus the actual lecture time are taken into consideration, the amount of teacher time gained could be considerable. Approximately 27 hours of class time are devoted to lecture presentation during the course. If the standard formula of two hours of preparation for every hour of presentation is used, the amount of time that might be gained by automating the lecture function could be as high as 81 hours of teacher time. Use of this time in personal consultation means that an average of 68 minutes per pupil per year could be contributed to individual consultation.

Although the time saved for preparation of presentations would not be applicable to the scheduled course time, more flexible procedures for scheduling activities would allow the students to consult with the teachers outside of regular course hours.

If lectures were automated, individual students could consult with the teacher during the time that the lectures are being presented; the materials would always be available for individual viewing.

When the possible advantages of automating the lectures to a greater degree are considered, the question is raised, "Why haven't the resources at Nova been used to automate the lectures?"

Nova personnel in the Social Studies course have been seriously concerned with this problem, and steps are continually being taken to make some progress in this direction. When the course was first started on a Continuous Progress basis, teacher lectures were recorded on audio tape; these tapes were available at the individual carrels in the learning resource center for call-up through the Chester Dialogue System. However, the teachers were concerned with the degradation of the instruction that could result from not having the visual aids to accompany the lectures. The teachers at Nova use the overhead projector activity in the lecture process. Frequently they develop their own visual aids because the lead time required for getting visual-aid material prepared by the Graphic Arts Department is longer than they can manage.

The faculty has considered the possibility of making video tapes of their lectures, but several problems have interferred with this idea. The facilities are available at Nova for making a video tape of the lectures and making the tapes available for group presentation through the CCTV system or by the TV monitors in carrels in the learning resource center. However, the cost of one video tape is $60. If the tapes were stored for use the next year--the cost could be as high as $4,260 (71 lectures x $60).

A second problem associated with using video tape recording for lectures is that the visual materials have to be specially prepared so that they can be recorded by the TV camera.

A third reason for not producing a library of tapes for lectures is that the social studies teaching staff is in the process of developing a new curriculum for social studies at Nova. One teacher, in fact, is working full-time on preparing materials for a Continuous Progress course in social studies that the school plans to implement again next year. The staff is hesitant to build a library of materials before they have had a chance to try them out first with classes and to evaluate them. However, it is planned that audio tapes will be made of the lectures next year so that the tapes will be available for individual students who miss the lectures.

The analysis suggests that much greater use of the media can be used at Nova. Teachers need to give serious consideration to the relative advantages of large group lecture versus individual consultation with the students.

One other problem regarding the use of media at Nova needs to be considered. If the school is successful in moving in the direction of the Continuous Progress Plan, television as a media resource may be insufficient for meeting the demand. Studies of students allowed to progress at their own rates in a Continuous Progress Plan show that as time goes along the students become more and more heterogeneous as far as their work on the courses is concerned. In time, few

students are working at the same point in the curriculum. The effect is that almost all students who want to view TV presentations individually want to view a different subject on tape. At any given time there can be as many different requests in one course as there are students. Obviously, a system that has a capability for providing no more than five or six different presentations at one time cannot meet the demand. One device that may eventually be less expensive and more appropriate to this kind of development is the 8 mm sound-movie cartridge for individual viewing.

The amount of time devoted to lecture plus the shortage of teacher time for individual contact during the large amount of time spent in independent study tends to create a learning environment that is not highly responsive to individual differences in ability and interests of the learners. One way to increase the responsiveness of the system is to develop more advanced information processing procedures.

3. Information Processing Procedures

Information processing procedures can be developed so that teachers are more aware of their students' needs and can plan their time in such a way that they can spend their limited time where it is most needed. Such procedures require more frequent testing, computer diagnosis of test data to define learning problems, and identification of those people who are in most pressing need of help. An information processing procedure with these capabilities has been discussed in greater detail in TM-1493/104/00, "System Design for a Continuous Progress School: Part II, Surveillance and Detection System," dated 13 March 1964. The document describes the procedures that might be used to record student performance and to identify students who need help. The title of the system has been changed to Instructional Management Information System. This new title places the emphasis upon providing the teacher with more information so that he can plan his use of time and his instructional activities more effectively. The system, by providing teachers with more and more timely information about student performance can allow teachers to treat the students more individually. The computer can collect and store the information and can make it available to the teacher when he is ready for it in a form that helps him make decisions in the interest of the individual student.

Certainly, as the course is moved back in the direction of the Continuous Progress Plan, the information processing procedures will become even more helpful.

If the teachers divide up the course so that each teacher on the social studies staff becomes responsible for specific units of work, the need for an information management system should be much greater. The teachers will not have the students for the whole course and will therefore have less opportunity to know the students. The computer, by collecting, keeping, and making available more information about the students, would help to overcome this problem. The teachers could get a history of each student from the computer. The history, in addition to grades

and test scores, could have comments that would be considered helpful by other teachers. These comments could include such things as both the perceptions that other teachers have of the student as an individual and the perception the student has of himself and others.

The plan to move the course operation back to the Continuous Progress Plan indicates that the space that is appropriate for large group instruction may not be appropriate for independent study.

4. The Arrangement of Spatial Resources

The number of carrels for individual study in the learning resource center is far too small to permit all of the students to use these spaces simultaneously. The carrels are designed for a plan where a limited number of students will use the area at any given time. If the school moves away from a heavy reliance on large group instruction to a more individualized plan, the resources for independent study will be grossly inadequate. The lack is already evident as witnessed by the fact that students doing research in groups must send a representative to the learning resource area rather than being free to go themselves.

The small number of carrels also makes it necessary for students to do their individual work in social studies at their classroom seats. These seats are adequate for listening to lectures and taking notes, but they are not appropriate for independent study. If the school does succeed in moving more and more in the direction of the Continuous Progress Plan, serious consideration should be given to acquiring a larger number of carrels for independent study. A plan to make better use of the resources at Nova and to allow for more individualized instruction is described in TM-1493/106/00, "System Design for a Continuous Progress School--Computer Simulation of Autonomous Scheduling Procedures." This plan calls for breaking away entirely from the lockstep system so that students, instead of being assigned to classes for hours, are free to work independently a large portion of the day and to be responsible for their own budgeting of time. The use of an advanced Instructional Management Information System enables students to schedule time with teachers and groups when such meetings are needed. It is recommended that Nova personnel be trained in the use of the computer simulation capability and that they use this tool to help them develop plans for better use of their resources. Finally, the effects of the procedures on the characteristics of students need to be considered.

5. Effects on the Characteristics of Students

It is difficult to define problems and trends in this area. If Nova continues to use the large group procedures that they are using in 10th-grade social studies, then students will progress in a lockstep fashion and will all tend to graduate in a defined and predictable number of years. Heterogeneity of performance with any course will tend to be very great for a number of reasons.

The resources will not be arranged in such a way that the system can respond well to the individual differences of the learners. The students with ability for better achievement who can work independently with little help will continue to do well, but the students with less ability will probably get only limited help and will continue to do poorly. The major variable that will affect performance will be the procedures used to select students rather than the procedures of instruction.

If the whole school moves more in the direction of the Continuous Progress Plan, the students will be able to be treated more individually. The instruction will tend to have more of an impact, the average performance of the students will be raised, but the rates of progress and the time of graduation will vary much more markedly. The effects of variations could be studied by Nova personnel with the simulation capability that has been developed in this project.

D. IMPLICATIONS OF THE RESULTS

A model of a year's operation of the 10th-grade social studies course was simulated on computer. The data produced by the simulated model was compared to data that was descriptive of the course. There was a high degree of comparability between the simulated data and the descriptive data which indicated that the computer simulation procedures that have been developed are effective in producing simulated data that appears to be valid.

The processes of formulation, computer programming, cycling of the program on computer, and analysis of the simulated output data did not provide either insights or hypotheses for analysis that could not have been obtained from analysis of the descriptive data. If the only end is to produce a computer simulation model of an existing course, the advantages that accrue do not seem to justify the cost.

Analysis of the 10th-grade social studies course identified a number of potential problem areas. In addition, a number of design solutions were recommended as alternatives for consideration in planning.

The following problems and suggested alternative solutions are defined:

1. Personnel Roles

a. Problems

(1) The student/teacher ratio in 10th-grade social studies is too high to allow for adequate concern for the individual student.

(2) "Small" groups are too large. From 16 to 25 students are assigned to work groups.

b. Solutions

(1) Increase staff size or reduce student body so the teacher/student ratio approaches 1/25.

(2) Increase dependence upon para-professionals and mature students.

(3) Restrict teacher responsibility for course content to units rather than total course.

(4) Double the number of small groups and use well trained students for leading such groups.

2. Use of Media

a. Problems

(1) A large amount of teacher time in the course (approximately 12%) is devoted to lecture presentation. Little use is made of media for presentation (approximately 3% of course time).

(2) Television system is not well suited at the present level of technical development to making a wide selection of programs at any given point in time. The fact that only five or six source channels are available imposes a real restraint on development of Continuous Progress procedures that would result in students needing access to a wide range of programs at any given point in time.

b. Solutions

(1) Seek funds to make and save video tape recordings for presentation of large portion of lectures. Contribute the teacher time that is saved to more work with individual students.

(2) Make audio tape recording of lectures for individual review of lectures.

(3) Give serious consideration to the use of less expensive procedures for individual viewing, such as 8-mm sound-movie cartridges with individual viewing devices.

3. Information Processing Procedures

a. Problems

(1) The large number of students, the limited teaching staff, and the lack of adequate information processing procedures make it difficult for teachers to be aware of the progress and problems of individual students. This lack of information reduces the efficiency of the way in which teachers spend their very limited time.

(2) Current procedures for scheduling students and teachers into classes probably does not allow for the most efficient use of resources. More flexible scheduling means are required for scheduling activities and for increasing the responsiveness to the needs of individual students.

b. Solutions

(1) Develop and implement data processing procedures for an Instructional Management Information System that will provide teachers and students with more information about students, more timely information about students. Include methods in the procedures for helping the teacher to spend their time most efficiently.

(2) Study new ways of organizing instruction by means of computer simulation, and develop rules for scheduling activities that are more efficient.

4. Use of Space

a. Problem

Plans in 10th-grade social studies are to try using Continuous Progress procedures again. Current space that is designed for individual study is very limited. Most independent study is done in a conventional lecture seat with an armrest for notetaking.

b. Solution

Give serious consideration to reducing dependence upon large group activities; install a large number of carrels in spaces now devoted entirely to large class instruction; possibly construct smaller group instruction spaces.

Estimates of the number of carrels, classes, etc., could be obtained by additional computer simulation studies.

5. Characteristics of Students

a. Problem

Current large group procedures at Nova do not seem to be well oriented to the poorer students.

b. Solution

Movement in the direction of Continuous Progress should facilitate providing more adequately for instruction that is adapted to the needs of the individual learner.